

performance, then optical interfaces 315-316 make connections to replace the inadequate working link with one of protect links 322. Thus, multiple service nodes, including IP service nodes, may share a pool of protect links.

5 Advantages

The invention can reduce the number of links required between matched pairs of IP routers. Fewer links are needed because the working links can be loaded to 80% or more. A pool of protect links is available and is shared among multiple services. The use of shared protect links is more efficient than providing a protect link for each working link.

For example, a prior art IP system may require 100 links that each has a 40% load. Using the invention, a new IP system may only require 50 links at an 80% load -- and access to the shared pool of protect links. The reduction in total links represents a cost savings to the communication system.

15

CLAIMS:

1. A communication system comprising:

an first Internet Protocol (IP) service node and a second IP service node;

a first telephony service node and a second telephony service node;

a first optical interface and a second optical interface wherein the first optical

5 interface is coupled to the first IP service node and the first telephony service node and
the second optical interface is coupled to the second IP service node and the second
telephony service node;

a first working link coupling the first optical interface to the second optical
interface and configured to transfer IP traffic between the first IP service node and the
10 second IP service node;

a second working link coupling the first optical interface to the second optical
interface and configured to transfer telephony traffic between the first telephony service
node and the second telephony service node; and

a shared protect link coupling the first optical interface to the second optical
15 interface and configured to transfer IP traffic between the first IP service node and the
second IP service node or to transfer telephony traffic between the first telephony service
node and the second telephony service node, wherein the first optical interface and the
second optical interface are configured to replace either of the first working link or the
second working link with the shared protect link.

2. The communication system of claim 1 further comprising:

a first Asynchronous Transfer Mode (ATM) service node and a second ATM service node wherein the first optical interface is coupled to the first ATM service node and the second optical interface is coupled to the second ATM service node; and

5 a third working link coupling the first optical interface to the second optical interface and configured to transfer ATM traffic between the first ATM service node and the second ATM service node, wherein the first optical interface and the second optical interface are configured to replace the third working link with the shared protect link.

10 3. The communication system of claim 1 further comprising:

a first Ethernet service node and a second Ethernet service node wherein the first optical interface is coupled to the first Ethernet service node and the second optical interface is coupled to the second Ethernet service node; and

15 a third working link coupling the first optical interface to the second optical interface and configured to transfer Ethernet traffic between the first Ethernet service node and the second Ethernet service node, wherein the first optical interface and the second optical interface are configured to replace the third working link with the shared protect link.

4. The communication system of claim 1 further comprising:

a first frame relay service node and a second frame relay service node wherein the first optical interface is coupled to the first frame relay service node and the second optical interface is coupled to the second frame relay service node; and

5 a third working link coupling the first optical interface to the second optical interface and configured to transfer frame relay traffic between the first frame relay service node and the second frame relay service node, wherein the first optical interface and the second optical interface are configured to replace the third working link with the shared protect link.

10

5. The communication system of claim 1 further comprising:

a first Storage Area Network (SAN) service node and a second SAN service node wherein the first optical interface is coupled to the first SAN service node and the second optical interface is coupled to the second SAN service node; and

15 a third working link coupling the first optical interface to the second optical interface and configured to transfer SAN traffic between the first SAN service node and the second SAN service node, wherein the first optical interface and the second optical interface are configured to replace the third working link with the shared protect link.

6. The communication system of claim 1 further comprising:

a first Multi-Protocol Label Switching (MPLS) service node and a second MPLS service node wherein the first optical interface is coupled to the first MPLS service node and the second optical interface is coupled to the second MPLS service node; and

5 a third working link coupling the first optical interface to the second optical interface and configured to transfer MPLS traffic between the first MPLS service node and the second MPLS service node, wherein the first optical interface and the second optical interface are configured to replace the third working link with the shared protect link.

10

7. The communication system of claim 1 wherein the first IP service node comprises a first matched IP router pair and the second IP service node comprises a second matched IP router pair.

8. A communication system comprising:
 - a first Internet Protocol (IP) router and a second IP router wherein the first IP router and the second IP router back-up each other to form a first matched IP router pair;
 - a third IP router and a fourth IP router wherein the third IP router and the fourth IP router back-up each other to form a second matched IP router pair;
 - 5 a first optical interface and a second optical interface;
 - a first working link coupling the first IP router to the first optical interface, a second working link coupling the second IP router to the first optical interface, a third working link coupling the third IP router to the second optical interface, and a fourth working link coupling the fourth IP router to the second optical interface;
 - 10 a fifth working link coupling the first optical interface to the second optical interface, wherein under normal operation, the first optical interface connects the first working link to the fifth working link and the second optical interface connects the fifth working link to the third working link to form a first working communication path from the first IP router to the third IP router;
 - 15 a sixth working link coupling the first optical interface to the second optical interface, wherein under normal operation, the first optical interface connects the second working link to the sixth working link and the second optical interface connects the sixth working link to the fourth working link to form a second working communication path from the second IP router to the fourth IP router;
 - 20 a first protect link coupling the first IP router to the first optical interface, a second protect link coupling the second IP router to the first optical interface, a third protect link coupling the third IP router to the second optical interface, and a fourth protect link coupling the fourth IP router to the second optical interface;

a fifth protect link coupling the first optical interface to the second optical interface, wherein under a first back-up operation, the first optical interface connects the first working link or the first protect link to the fifth protect link and the second optical interface connects the fifth protect link to the third working link or the third protect link

5 to form a first protect communication path from the first IP router to the third IP router;

a sixth protect link coupling the first optical interface to the second optical interface, wherein under a second back-up operation, the first optical interface connects the second working link or the second protect link to the sixth protect link and the second optical interface connects the sixth protect link to the fourth working link or the fourth protect link to form a second protect communication path from the second IP router to the fourth IP router;

10 wherein under a third back-up operation, the first optical interface connects a first non-IP service link to the fifth protect link and the second optical interface connects the fifth protect link to a second non-IP service link to form a third protect communication path for a non-IP service; and

15 wherein under a fourth back-up operation, the first optical interface connects a third non-IP service link to the sixth protect link and the second optical interface connects the sixth protect link to a fourth non-IP service link to form a fourth protect communication path for a the non-IP service.

9. The communication service of claim 8 wherein the non-IP service comprises telephony service.
10. The communication service of claim 8 wherein the non-IP service comprises 5 asynchronous transfer mode service.
11. The communication service of claim 8 wherein the non-IP service comprises frame relay service.
- 10 12. The communication service of claim 8 wherein the non-IP service comprises Ethernet service.
13. The communication service of claim 8 wherein the non-IP service comprises storage area network service.
- 15 14. The communication service of claim 8 wherein the non-IP service comprises multi-protocol label switching service.